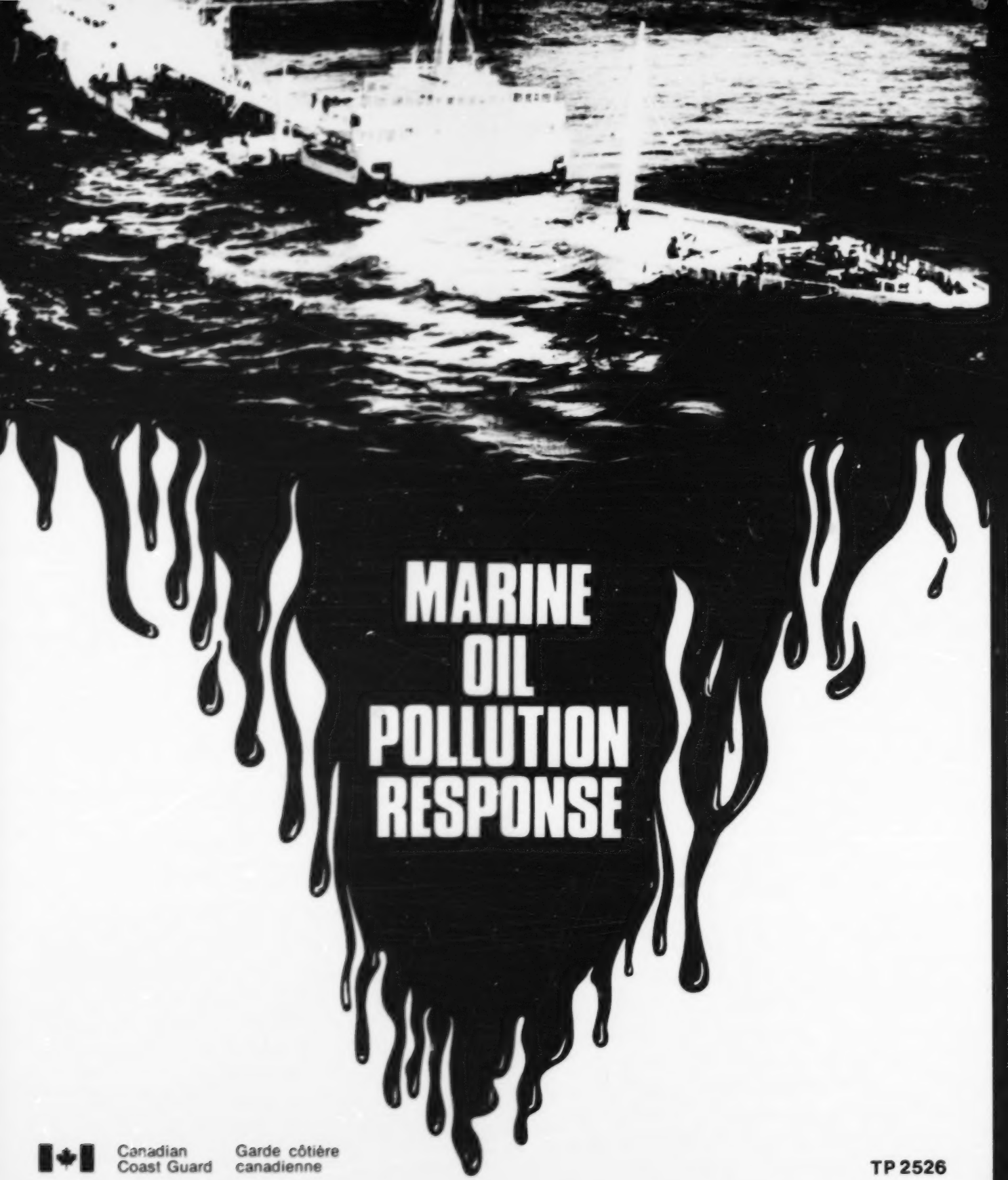


MARINE OIL POLLUTION RESPONSE

Canadian Coast Guard
Garde côtière canadienne

TP 2526

90-04031/

Heavily oiled foreshore

Tanker approaching Port Hawksbury terminal

Annually, some 36,000,000 tons of oil and oil product are transported in about 28,000 vessel movements in Canadian waters. In addition to the Canadian traffic, there are large international trades. The Great Circle tracks from Europe to North America pass off Newfoundland and the Alaskan tanker trade passes down our west coast.

The Canadian fishing industry, in general, depends upon availability of different types of fish. The economies of the four Atlantic Provinces rely heavily on fish, shellfish such as clams, scallops and lobster, and, in some areas, the gathering of Irish Moss. On the West Coast, both the salmon and herring fisheries have substantial economic importance. In addition, there is a significant tourist trade on both coasts and the Great Lakes, not only from within Canada but also from the United States and elsewhere.

Fishing is not the only industry that can be affected by an oil spill. Oiled logs cannot be put through a mill, oiled marinas have to close, any industry drawing its water from the area may have to cease or slow operations and, of course, oiled beaches do not attract tourists.

Canada's northern climate can inhibit responses to marine oil spills. The adverse effect of the harsh winter climate not only increases the time oil takes to degrade naturally but also the time required to clean up spills effectively, particularly in ice-covered waters.

M.T. Manhatten in the Arctic

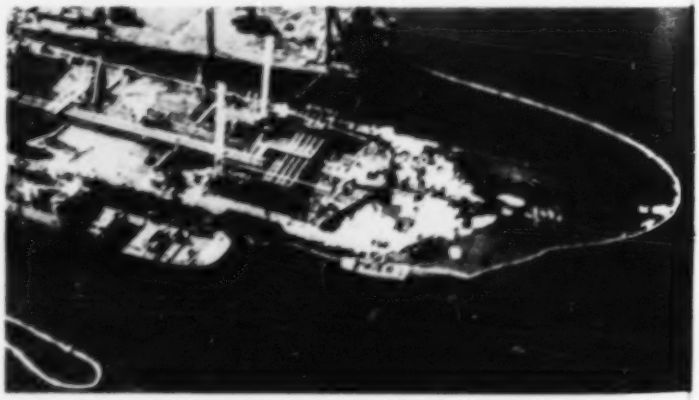
What Is Being Done?

After the tanker Arrow disaster at Chedabucto Bay in 1970, the Parliament of Canada changed the Canada Shipping Act to strengthen its capability to deal with pollution from ships. These changes were promulgated as Part XX of the Act in 1971. While the thrust of the legislation is that the polluter shall do his own clean-up, it also provides that, where a polluter is either unwilling or unable to undertake cleanup, the government will step in and take whatever action it deems appropriate, according to the particular circumstances of the incident. The authorities can destroy, if necessary, or remove, if possible, and sell or otherwise dispose of the ship, its cargo or other material on board. Any proceeds can be applied against the expense incurred. The Act prohibits any oil discharge whatsoever and makes the reporting of oil spills mandatory. The Canada Shipping Act is administered by the Canadian Coast Guard.

The Maritime Pollution Claims Fund (MPCF) was established under Part XX of the Act. This fund provides for contributions from the oil industry of not more than 15 cents per ton of oil landed at, or shipped from, a Canadian port. The fund handles unsatisfied judgments for injured parties with respect to oil pollution damage, such as equipment losses to fishermen. Although contributions were discontinued in August, 1976, they could be levied again should the fund which amount to $157,000,000 in mid 1989, become depleted.

The Canada Shipping Act was amended and streamlined in 1989. The maximum fine was raised from $100,000. to $250,000., the M.P.C.F. was changed to the Ship Source Oil Pollution Fund, and Canada acceded to both the 1969 International Convention for Oil Pollution Damage and the 1971 International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage.

The Canadian Coast Guard operates a fleet of 119 ships, 4 hovercraft, 35 helicopters, 1 fixed wing



Offloading operations on the stern section of the Kurdistan

CCG Emergencies Fast Work Barge

CCG Hovercraft

aircraft, and many smaller craft of various types. In addition, it has marine pollution countermeasures equipment worth over $35 million based at 55 locations across Canada, as well as 53 Emergencies personnel dedicated to pollution countermeasures. These personnel respond under a number of international, national, regional, district, and local contingency plans. The Coast Guard can also draw on any other federal, provincial, or other government agency, or any commercial or private organization, for additional personnel and resources. For example, Regional Environmental Emergency Teams consisting of personnel from Coast Guard, and the Departments of the Environment and Fisheries and Oceans are activated to advise the On-Scene-Commander during the course of responses.

Behaviour of Oil at Sea

Escaped oil drifting with wind and current

1. ***Movement***

In the absence of ice, the movement of oil on the surface is governed by wind and current, tidal and/or riverine. Generally oil will drift at 3% of the wind speed and direction compounded by 100% of the current speed and direction. However, as real time, localized conditions can not always be calculated, spill trajectory modelling is very much an inexact science.

2. ***Weathering***

The moment oil is spilled upon the sea's surface a number of physical and bio-chemical processes begin. These, in effect, reduce the concentration of the oil on the water. The processes are known collectively as "weathering." Crude oil is not a pure chemical but consists of hundreds of compounds made up of hydrogen and carbon (hydrocarbons) and some dissolved gases. Individual petroleum hydrocarbons fall into four general classes because of common features in their molecular structure: paraffins, naphthenes, aromatics and olefins. The molecular structure of these compounds, in turn, influences the boiling point, specific gravity and viscosity (stickiness) of each constituent of crude oil. Thus, crude oil is refined into such products as gasoline, fuel oil and lubricants within a defined boiling point range and according to specific gravity and viscosity. Crude oil may contain dissolved gases, which can vaporize at atmospheric pressure, as well as a number of substances, including sulphur, nickel, and vanadium.

Weathering, then, varies in intensity according to the type of oil spilled and the meteorological and water conditions at the time of the spill. Forms of weathering include evaporation, dissolution, emulsification, oxidization and biodegradation.

(a) ***Evaporation:*** This is the loss to the atmosphere of those components of the crude oil that have relatively low boiling points, referred to as "light ends." Evaporation can reduce the total volume

Shoreline contamination

of crude oil by as much as 25% within one day. This percentage varies with the temperature of the sea water, water conditions and winds. Products such as gasoline can evaporate by half of their original volume in warm weather. On the other hand, No. 6 fuel oil (Bunker C), with no "light ends," evaporates very little, if at all.

(b) ***Dissolution:*** Only a small proportion of the hydrocarbon constituents of oil are soluble in water, so only a very small part of the total spill can dissolve. However, this small amount is significant because dissolved oil is toxic to certain forms of marine life.

(c) ***Emulsification:*** Following an oil spill, wave movements cause water to become trapped in the oil thus forming water-in-oil emulsions. The oil may contain as much as 75% sea water by volume and will take on a brownish or reddish appearance, known as "chocolate mousse". When large amounts of sea water are emulsified in the oil, the slick becomes denser and, when sediments are added, a portion of it may sink.

When small droplets of oil are detached from the slick and distributed throughout the upper layers of the sea water, an oil-in-water emulsion is formed. Breaking up of slicks into small droplets can be speeded up by the addition of chemical oil dispersants.

(d) ***Biodegradation:*** Each type of microorganism can break down, or degrade, only one or two of the hydrocarbons found in oil. Nature provides sufficient diversity within the overall microbial population, however, to completely degrade most of the different hydrocarbons found in crude oil. In sum, the rate at which the oil breaks down depends on the number of different microbes in the immediate vicinity of the oil. This, in turn, depends on the temperature (optimum between 20° and 30° C) and the availability of oxygen and nutrients such as nitrogen and phosphorous compounds. An oil spill in the Canadian Arctic would, therefore, degrade much more slowly because of the colder temperatures and the lack of nutrients in northern waters.

Oil that sinks and is silted over is deprived almost completely of oxygen, so it breaks down extremely slowly. On the other hand, oil dispersed in droplets within the upper layers of water is exposed to warmer conditions and a replenishable supply of oxygen and nutrients.

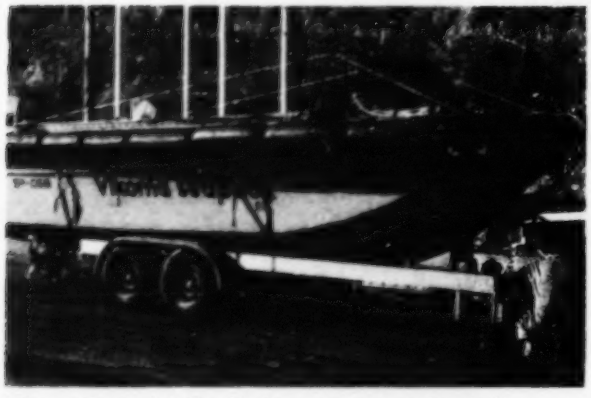
(e) ***Oxidization:*** The chemical interaction of hydrocarbons with oxygen, called oxidization, is another weathering process, but a slow one. Oxidization is believed to occur at the water's surface where there is an abundance of atmospheric oxygen, especially when the slick is very thin. Ultra-violet light can act as an agent, or catalyst; hence the term photo-oxidization.

Canadian Response Capability

In general, the oil industry has developed limited countermeasures capabilities such as the localized cooperatives in Burrard Inlet, British Columbia, or the East Coast Spill Response Incorporated (ESRI) in St. John's. Canada has some 242 000 km of maritime coastline, however, and these cooperatives have no means of responding to a situation outside their own localities. Accordingly, the Canadian Coast Guard established a national response organization, Canadian Coast Guard Emergencies, with its headquarters in Ottawa. It has regional managers, for emergency operations (RMEOs) in each of the six Coast Guard regions. These managers, in turn, have personnel to maintain and operate the oil spill countermeasures equipment.

To maximize its advantage, the equipment must be available for use at any particular site where a risk of shipping-related spills exists. For this reason, ease of transportation by road, rail, vessel and air freight is a major factor in choosing the equipment. Large oil skimming vessels, for example, not only are exceedingly expensive but are difficult to move to an area outside their normal limits of operation.

Since the oil spill equipment requirements for any one incident can quickly exceed the hardware available in any Coast Guard region, extra equipment must be brought in from other regions. The hardware throughout the national inventory must therefore be uniform in design. Within this context, equipment is purchased for three basic areas of operation. In order of priority, they are transfer, shoreline protection and restoration and open water recovery.



Vikoma Seapack inflatable boom in its container hull

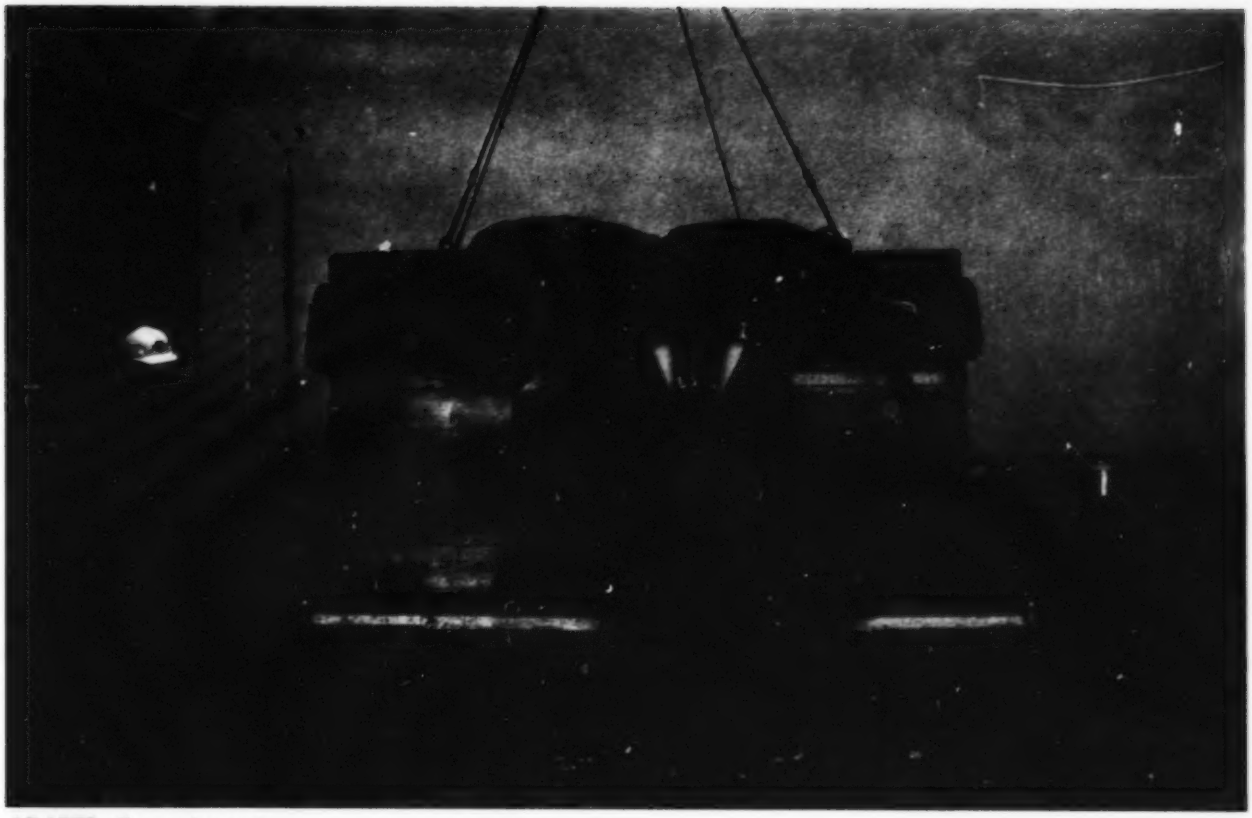
Transfer Equipment

In order to prevent the loss, or further loss, of oil from a casualty, it is sometimes necessary to transfer the oil into another vessel or shore tank, or to another sound tank within the casualty.

When an oil tanker has grounded, each tidal cycle increases the possibility of structural damage to the ship which, in turn, can result in oil pollution. Often a ship's tanks will be pierced and partially flooded with sea water. If the cargo pump inlets are submerged in sea water, the ship's own pumping facilities cannot be used to remove the oil from the ship's tanks. If the engine room is flooded, the vessel will be without power. For such emergencies, the Coast Guard has invested in self-contained transfer systems. One such system is the ADAPTS, a diesel-driven, hydraulically-powered submersible pump. This unit has been used in emergency transfer operations in Canada and in other countries.

Another emergency system is the FRAMO offloading pump, which is used for larger operations requiring the movement of greater volumes of fluid from VLCCs (Very Large Crude Oil Carriers). FRAMO units have approximately 10 times the pumping capacity as ADAPTS, and they can move corrosive materials or large volumes of water in a vessel salvage operation.

A tanker on the rocks can mean oil pollution



ADAPTS oil pumping system

Shoreline Protection and/or Restoration

The shoreline has second priority since an oil spill makes its most visible impact here. Waterfowl nesting areas in lagoons or marshlands, are, of course, susceptible to oil coming ashore. Tourists tend to avoid areas polluted by oil. In addition, the inshore fishing industry may be affected, since oiled boats and gear may make a catch unsalable or deprive a fisherman of a season's employment. Fish processing plants may be forced to stop their operations if an oil slick contaminates a factory's water intake.

Because a shoreline can vary from marshland to mud flats, from a hard-packed sandy beach to a rocky coast, all with varying degrees of accessibility from the shore or from the sea, no single technique can be used to resolve all problems.

Oil booms may be used to protect an area from an advancing oil slick or to concentrate or retain oil in a confined area. With present technology, booms are not effective in rough water or where the current exceeds one knot. However, research in this critical area is continuing.

In most oil spills, cleanup work starts along the shoreline and in areas where oil has collected in pools or behind booms. A number of different skimming

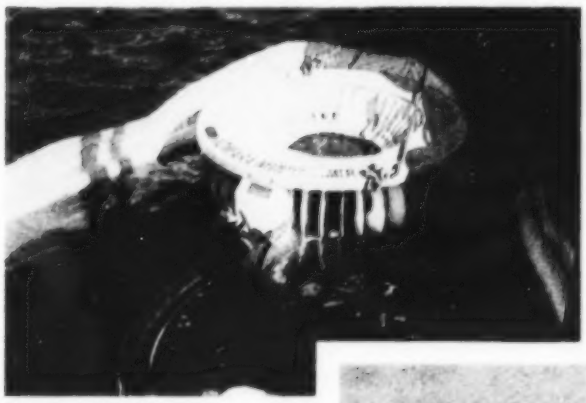
A casualty of oil pollution

machines can be used to remove oil from the surface of calm water, such as that often found in harbours. The Coast Guard has a number of types, including the Komara and Morris disc skimmers. An Oil Mop may be used in areas where access is restricted by pilings and cribwork.

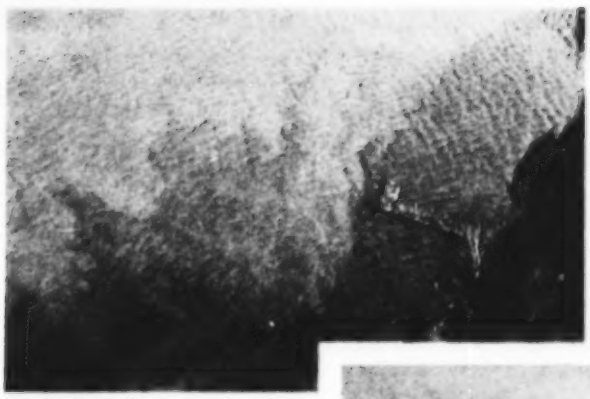
Since 1971, most oil spills in Canadian waters have involved heavy fuel oil (Bunker C). This oil, burned as fuel in ships among its other uses, is normally transported at 40-60° C, and becomes very thick and sticky and hard to handle when cooled to normal water temperatures. This oil can be removed from the water's surface in good conditions, using the Coast Guard's re-engineered slick-licker, Archimedean screw pumps, or a specially adapted version of a hay loader called the Oil Harvester.

Cleaning up the shoreline often involves the removal of beach sand as well as oiled debris. In some instances, the debris can be burned and the Coast Guard is researching how to improve this process. If it is mixed with gravel or other debris, it must be removed with heavy machinery or by people using hand tools.

A large part of the Coast Gaurd's national inventory consists of vehicles, communications gear, generators, lights and work boats. Steam generators are indispensable for removing oil from pilings, stone work and vessels, and even from countermeasures gear that becomes oiled during the clean-up operation.



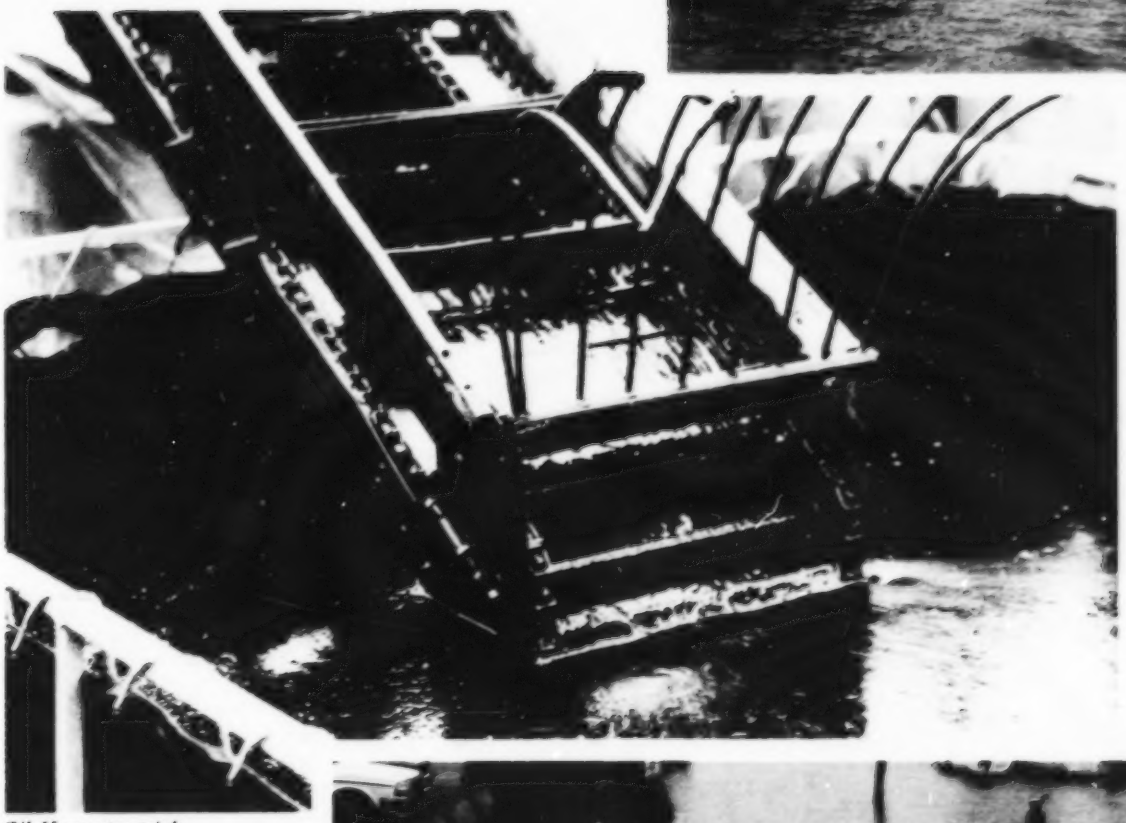
Komara disc skimmer



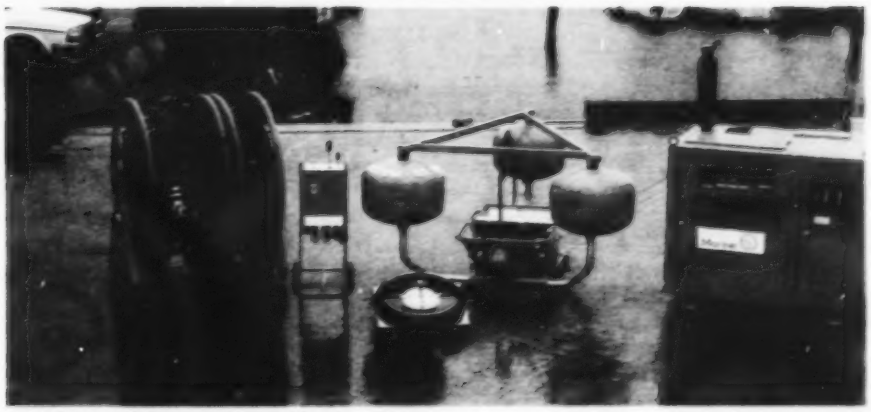
Emulsified oil or "chocolate mousse"

Oil Mop

The usual source of oil pollution is vessel casualties

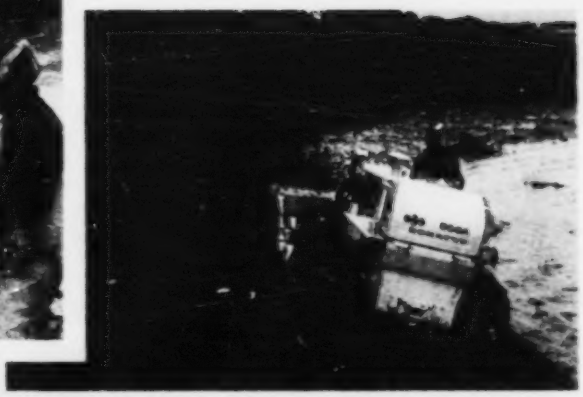


Oil Harvester trials



GT-185 Archimedean screw skimmer

Cleanup crew using hand tools



Heavy machinery used to clean a shoreline

Steam cleaning oiled dockside

Occasionally oil can be disposed of through burning

Open Waters

These waters have third priority because cleanup techniques are least likely to be effective here. This is due primarily to adverse weather conditions, which exceed the capability of the hardware and techniques available to date. For exampie, the effectiveness of any containment boom is greatly reduced by rough water. In addition, the use of booms and other equipment becomes difficult, if not dangerous, in bad weather. Nevertheless, for certain marine accidents such as an offshore oil well blowout or a damaged tanker, all efforts must be made to minimize the spread of oil pollution.

For operations offshore, the Coast Guard equipment can be deployed from Coast Guard ships or vessels of convenience such as fishing trawlers, or offshore supply vessels that service petroleum exploration ventures.

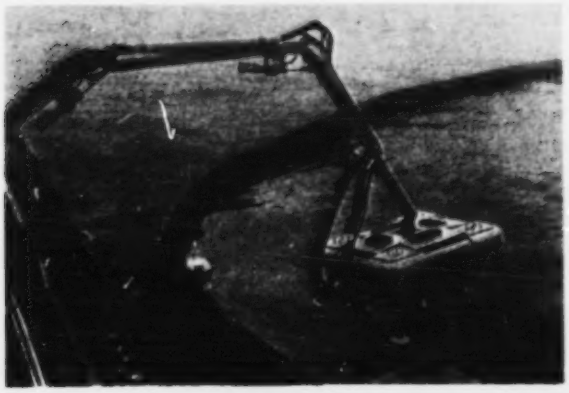
Vikoma Seapack deployed

In general, the Canadian Coast Guard has elected to use highly portable inflatable booms as a quick means of containing oil on the water. There are three kinds in the national inventory: the Seapack, which is deployed from its own hull, and the Oceanpack and the Ro-boom which are deployed from the deck of a vessel. These booms are rugged, yet flexible enough to follow the contours of an ocean swell. With this equipment, a crew can rapidly deploy 450 metres of oil boom.

The main skimming device used offshore is the FRAMO ACW-400 disc skimmer. This unit, operated from the deck of a vessel, consists of a disc-type skimmer head with a sump pump that transfers the recovered fluids to holding tanks. The unit is put into position by a hydraulically-powered articulated arm that lets the skimmer head float on the water's surface. The oil booms and ACW-400 must be used together, along with a vessel with tanks large enough to hold the recovered fluids. Such a deployment, using two booms, skimmers and transfer pumps, could involve three or four ships.

Another countermeasures technique is the use of oil spill dispersants. These act on the surface and help break down oil slicks into droplets that disperse in the water. However, there is concern that widespread use of these agents during a major oil spill may cause more environmental damage that the oil

ACW-400 disc skimmer recovering oil contained by a Seapack boom



Ro-boom deployed

Heli-Torch ignition trials

alone. Research is also being pursued into various methods of igniting oil which is floating on the water's surface.

In addition to its network of international, national, regional, district, and local plans, the Coast Guard, other Government agencies, industry, and U.S. personnel augment their response capability through periodic exercises and ongoing training courses. Extensive training materials have been developed to support their activity,

Energy conservation notwithstanding, the Canadian population and industries will continue to use large quantities of oil and chemicals with the resulting transportation and storage problems. While government and industry have made significant progress in preventing pollution, there always will be somebody who turns the wrong valve or does not read the chart properly. The pollutant will escape from its tank and an appropriate response will have to be raised.

The Canadian Coast Guard, in conjunction with other federal and provincial departments and industry, must therefore, continue to maintain and improve its ability to respond to marine oil spills.